If no other values are agreed upon during coordination, the satellite system licenses will be subject to these default values. If different values of maximum downlink PFD spectral density and/or maximum aggregate uplink EIRP areal spectral density are agreed upon during coordination, the licensees would certify to the FCC that agreement has been reached on these values. The specific provisions of Part 25 of the FCC's rules would include only reference to the existence of default values imposed on licensees in the absence of coordination agreement, and the default values recommended by this Report would be specified as the initial coordination default values by the FCC in its Report and Order in this rulemaking proceeding.

As a general technical matter, this approach can be applied to both spread spectrum and non-spread systems, as well as to LEO and GEO systems. However, practical sharing results may not be obtained for specific spread and non-spread systems with widely different characteristics. For example, the proposed Motorola system could not share spectrum co-frequency, co-coverage with any of the proposed CDMA systems.

2.2. Band Segmentation.

A band segmentation approach to sharing the MSS frequencies requires that: (1) each system is authorized to operate in some segment of the 1610-1626.5 MHz band,[3] which might or might not be an exclusive spectrum assignment; and (2) criteria are established for assigning spectrum segments to each authorized system. The following is a description of the band segmentation options considered.

2.2.1. Motorola Band Segmentation Plan. Motorola has proposed a plan for segmenting the 16.5 MHz of uplink spectrum into two 8.25 MHz wide sub-band segments based on access technology (IWG1-3, IWG-34). This band segmentation proposal relates to the uplink. Motorola takes no position as to how the S-band downlink should be shared. The basic elements of this plan for domestic implementation are as follows:

(1) All qualified applicants would receive a permit to construct systems that can operate over both bands in

---

[3] The band segmentation options considered here involve assignments only in L-band; it is anticipated that CDMA systems transmitting downlinks in S-band would operate in that band on the basis of full band interference sharing. It was also assumed for the description in this section that the entire 16.5 MHz of L-band was usable for MSS uplinks.

their entirety (i.e., up to 33 MHz), or as much thereof as they have requested in their applications.

(2) The first operational system would be permitted to use both bands in their entirety in the U.S., or as much thereof as it has been authorized to use. A system would be considered "operational" when it commences providing commercial MSS services as authorized by the Commission.

(3) If two systems become operational and both employ the same type of access technique, they would coordinate use of the uplink band with each other as follows:

(a) If both are FDMA/TDMA systems on the uplink, they would share the 16.5 MHz (or the top 10.5 MHz if both are bi-directional) through "dynamic sharing" (see below) or some other coordinated approach. If one of these systems is not operating on a bi-directional basis, its initial allocation would be in the lower portion of the band.

(b) If both are CDMA systems on the uplink, they would share the 16.5 MHz through "interference sharing" in the manner proposed by the CDMA applicants in Section 2.1.

(4) If two systems become operational and employ different types of modulation techniques, the uplink band would be partitioned into two equal sections as follows:

(a) The FDMA/TDMA system would operate in the upper half of the L-band (1618.25-1626.5 MHz). This assignment is made because (i) an allocation for bi-directional operations has been proposed for this band, (ii) EIRP density limits are sufficiently high, and (iii) co-frequency, co-coverage sharing is not feasible with existing users such as the Radio Astronomy Service in the lower portion of the band.

(b) The CDMA system would operate in the lower half of the band (1610-1618.25 MHz).

(5) If three or more systems become operational and all systems employ the same type of modulation technique, they would coordinate use of the uplink band as follows:

(a) If all are FDMA/TDMA systems, they would share the entire uplink band (or the top 10.5 MHz if all are bi-directional systems) through dynamic sharing or some other coordinated approach. If one of these systems is not operating on a bi-directional basis, its initial allocation would be in the lower portion of the band.

(b) If all are CDMA systems, they would share the entire uplink band through interference sharing.

(6) If three or more systems become operational and at least one employs a different type of modulation technique than the others, the uplink band would be partitioned into two equal sections as follows:

(a) FDMA/TDMA systems would share the 1618.25-1626.5 MHz portion of the band through dynamic sharing or some other coordinated approach. See item 4(a) above.

(b) CDMA systems would share the 1610-1618.25 MHz portion of the band through interference sharing.

(7) Under dynamic sharing, the FDMA/TDMA segment of the band would be partitioned among the FDMA/TDMA systems, with bi-directional systems being assigned spectrum at the top of the band. Initial assignments would be coordinated between licensees with an understanding that new entrants would receive sufficient spectrum to begin operation. The amount of spectrum assigned to each system would be periodically adjusted (e.g., every three months) in accordance with the traffic demand of each system in the United States. The periodic adjustment of the FDMA/TDMA partitions would be based on both originating and terminating billed minutes of use in the United States in accordance with the following formula:[4]

---

[4] Billed minutes of use information should be readily available because every system operator will have to keep these data for billing purposes. If a system leases capacity on a private line basis, a modified dynamic sharing methodology would be applicable. Any disputes involving the adjustment of band segments could be resolved in accordance with procedures established by the FDMA/TDMA licensees (e.g., independent arbitrator). Thus, the Commission's role in this process would be limited to approving the ground rules for partitioning of the FDMA/TDMA spectrum.

$$\text{Allocated Bandwidth Per System} = \frac{\text{Billed Minutes of Use Per System}}{\text{Sum of All Billed Minutes of Use for All Systems}} \times \text{Total FDMA/TDMA Bandwidth (MHz) Available}$$

The foregoing description of Motorola's proposed band segmentation plan is illustrated in Figures 1-5.

2.2.2. Band Segmentation by Number of Applicants. IWG1-51 discusses another method of band segmentation, i.e., by number of applicants (licensees). This approach would divide the entire 16.5 MHz uplink band equally between the number of current applicants or licensees (1/n) or between current licensees and possible future applicants (1/n+1). Under the 1/n approach, since there are six applicants in the current case, each would be assigned 2.75 MHz of spectrum (assuming each receives licensing and construction authority from the FCC). If a future system were to be licensed, several methods for apportioning the previously assigned spectrum could be followed. For example, each of the initial six licensees could be required to surrender a proportional amount of spectrum to the newcomer. An alternative would be to determine which of the initial licensees were not utilizing the spectrum assigned to its full capacity and require only those licensees to contribute their unused spectrum to the newcomer. Yet another approach would be to require the newcomer to wait until one of the initial licensees were to fail or surrender its spectrum before any spectrum would be assigned to it.

As an extension to this approach, and to better accommodate new entrants, systems that are capable of doing so may be permitted or required to share on an interference basis by aggregating their assigned segments and jointly operating within the aggregated sub-bands. This, however, would require only those systems that can share on a full band interference basis to provide spectrum to newcomers, effectively leaving the exclusivity granted to the FDMA/TDMA systems intact. *See* Figure 6.

2.2.3. Band Segmentation by Channelization. Under this approach, also discussed in IWG1-51, the entire 16.5 MHz uplink band would be divided into a fixed number of channels with potentially both initial and traffic growth assignments. For example, the band could be standardized on the existing terrestrial cellular channelization scheme and thus divided into thirteen (13) 1.25 MHz channels. Each licensee could initially be assigned one channel each in the upper and lower portions of the band. Also, to maximize sharing, those channels assigned to CDMA licensees could be aggregated and shared on a full band interference basis. Channels not initially assigned to licensees would be reserved for growth of licensed systems and/or possible newcomers. See Figure 7.

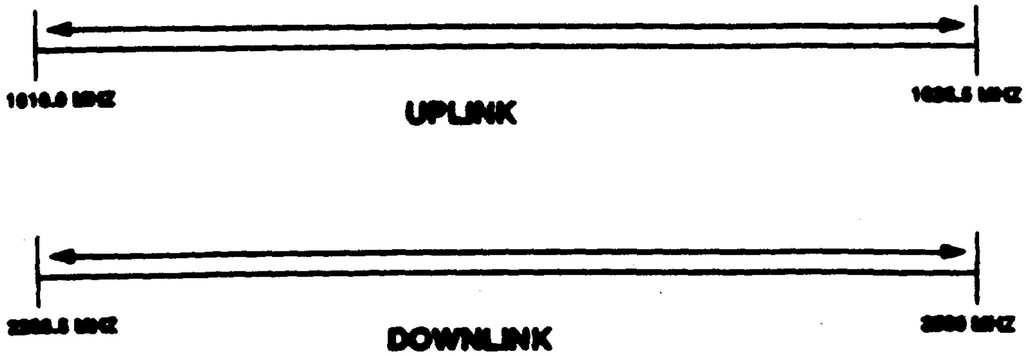
2.2.4. Band Segmentation by Dynamic Band Sharing. Spectrum is assigned on a dynamic basis. As systems are licensed and come on line, the band is loaded and spectrum assigned in specific accordance with individual system requirements and anticipated demand experience at the time of spectrum assignment. There would be no predetermined sub-bands or channelization schemes. See Figure 8.

2.2.5. Full Band/Polarization Segmentation Sharing. Another approach to band segmentation, specifically designed to accommodate the single FDMA/TDMA applicant proposing bidirectional operation, involves the use of polarization isolation as a means of achieving sharing of the spectrum. This proposal is discussed in detail in Section 5.2.

FIGURE 1.

MULTIPLE ENTRY SPECTRUM SHARING

- SINGLE SYSTEM OPERATION (CDMA)

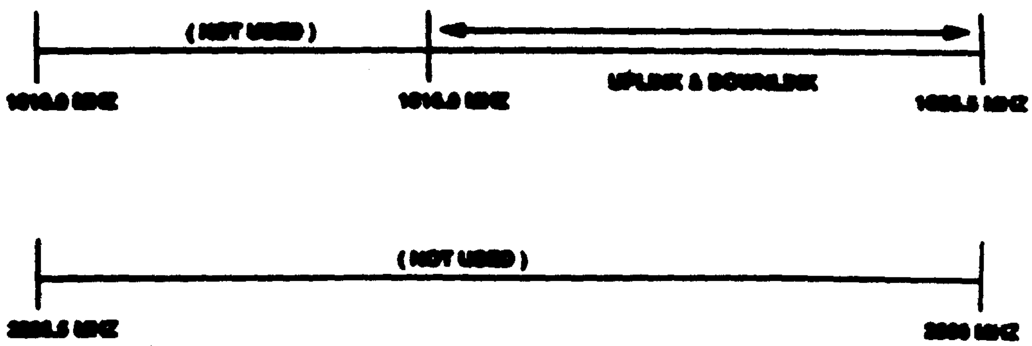


TOTAL BANDWIDTH USED: 33 MHZ

FIGURE 2

MULTIPLE ENTRY SPECTRUM SHARING

- SINGLE SYSTEM OPERATION (FDMA - BIDirectional)

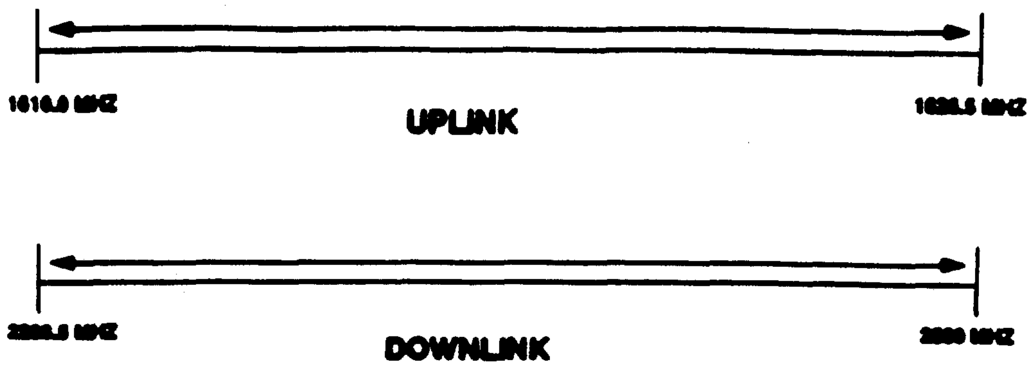


TOTAL BANDWIDTH USED: 10.5 MHZ

FIGURE 3

MULTIPLE ENTRY SPECTRUM SHARING

- FIRST TWO OPERATIONAL SYSTEMS ARE CDMA

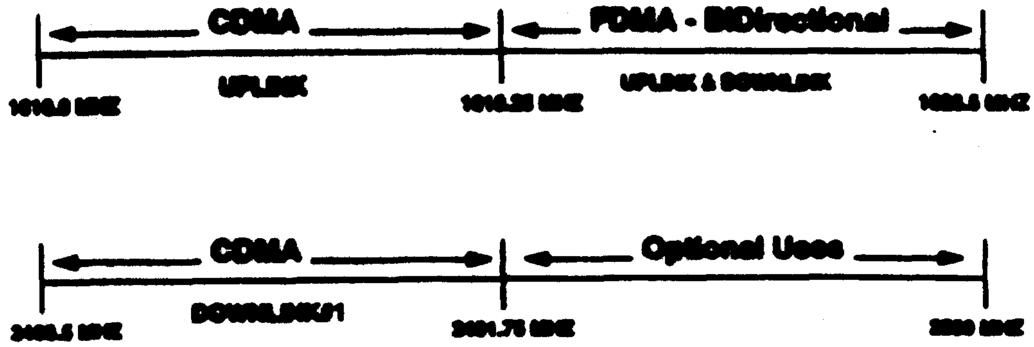


TOTAL BANDWIDTH USED: 33 MHZ

FIGURE 4

MULTIPLE ENTRY SPECTRUM SHARING

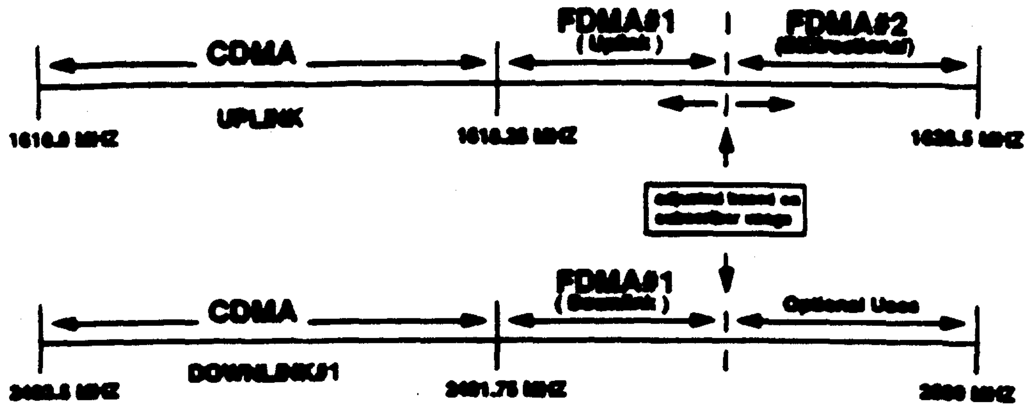
- FIRST TWO OPERATIONAL SYSTEMS ARE CDMA & FDMA-Bi Directional



TOTAL BANDWIDTH USED: IRIDIUM - 8.25 MHZ
CDMA - 16.5 MHZ

MULTIPLE SYSTEMS / DYNAMIC SHARING

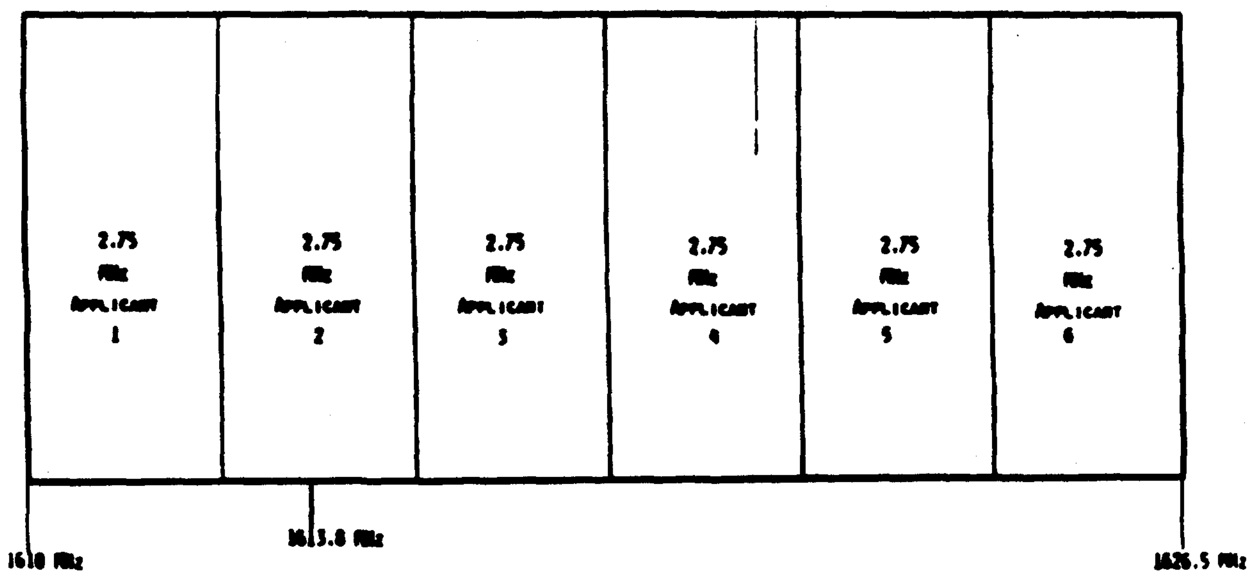
- **FIRST THREE OPERATIONAL SYSTEMS ARE: ONE CDMA, ONE Dual Band FDMA, AND ONE FDMA - Bi Directional**



TOTAL BANDWIDTH USED: CDMA - 16.5 MHZ
FDMA's - Based on usage

FIGURE 6

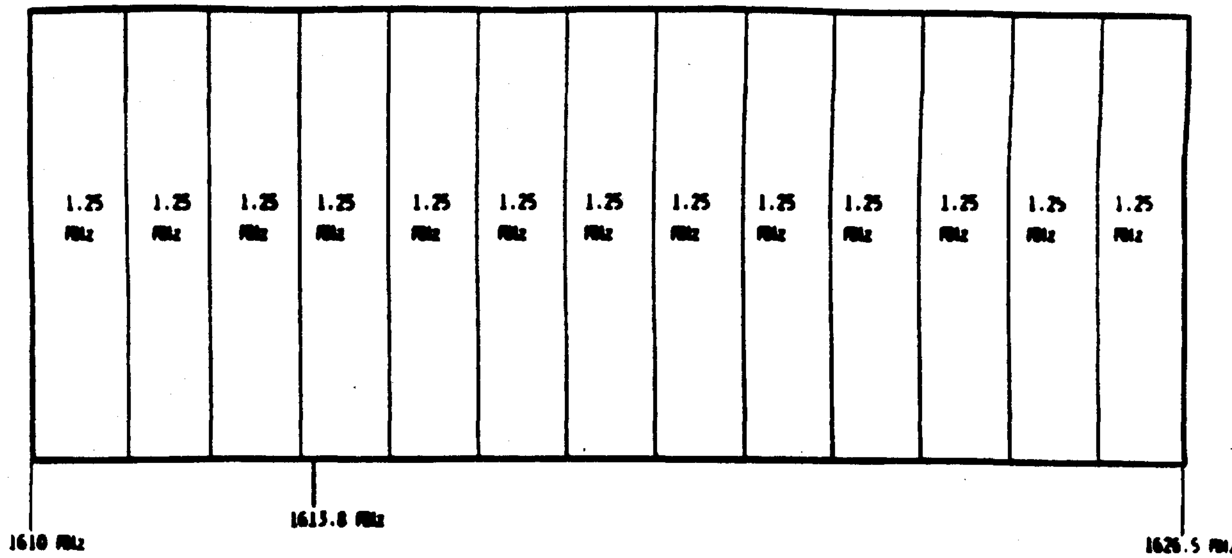
UPLINK
BAND SEGMENTATION OPTION
BY NUMBER OF APPLICANTS



ALLOCABLE SEGMENTS OF L-BAND MAY REQUIRE ADJUSTMENT IF ANY SUBPART PROVES TO BE UNUSABLE.

FIGURE 7

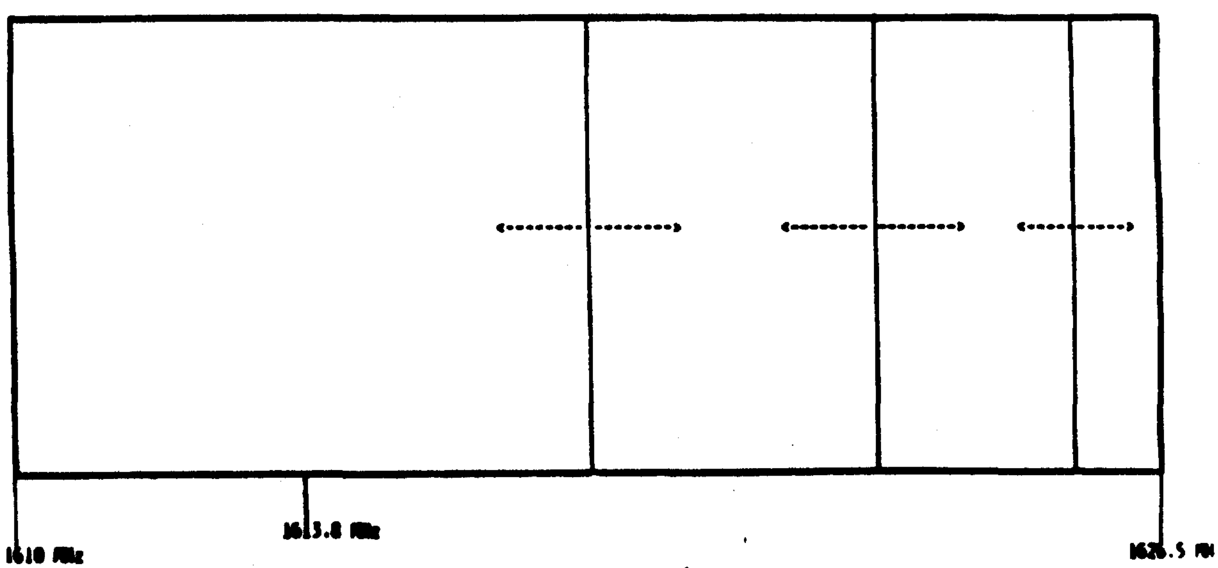
UPLINK
BAND SEGMENTATION OPTION
CHANNELIZATION



ALLOCABLE SEGMENTS OF L-BAND
MAY REQUIRE ADJUSTMENT IF ANY
SUBPART PROVES TO BE UNUSABLE.

FIGURE 8

UPLINK
BAND SEGMENTATION OPTION
[illegible]



ALLOCABLE SEGMENTS OF L-BAND
MAY REQUIRE ADJUSTMENT IF ANY
SUBPART PROVES TO BE UNUSABLE.

Annex 2.1: Default Coordination Values

2.1.1 Downlink PFD

S-Band downlink interference sharing is specified in terms of a maximum value, p $dBW/m^2/4kHz$, the ground level power flux spectral density from all the satellites of any one system at any point in the CONUS. As a starting range for negotiations, it is suggested that maximum values of p in the range -142 to -137 $dBW/m^2/4kHz$ per system appear appropriate. In default of successful negotiations, each system will be allocated -137 $dBW/m^2/4kHz$ maximum. To account for such variations as voice activity and power control this value will be measured after an averaging period of two seconds, although the instantaneous value shall not be more than 3dB above the average. Since systems may experience occasional loading peaks, each shall be allowed to exceed these levels by a maximum of 2dB no more than one half of one percent of the time.

2.1.2 Uplink EIRPD.

L-Band uplink sharing is specified in terms of a maximum effective uplink EIRP areal density, e dBW/4kHz, emanating from all the subscriber units of any one system in an area of defined size. Since the defined area average EIRPD is a result of a summation over the independently random and possibly autonomous power control fluctuations of many different terminals, it's maximum value may be ill defined. Thus, it may be necessary to specify the maximum criterion in terms of an exceedance probability for a given averaging condition.

It is considered appropriate to specify a maximum EIRPD for several different areas, which correspond to likely antenna beam sizes of MSS systems. The values specified for larger areas serve to limit the total power that the satellites from any one system can radiate, while the values set for smaller areas constrain larger systems from concentrating all their users in one spot, to the detriment of systems with smaller beams.

In default of successful negotiations, each system will be allocated the right to radiate -20 dBW/4kHz in any area of 10,000 square nautical miles, but not more than -15 dBW/4kHz from any area of 200,000 nm^2. To account for such variations as voice activity and power control these values will be measured after an averaging period of two seconds, although the instantaneous value shall not be more than 3dB above the average. Since systems may experience occasional loading peaks, each shall be allowed to exceed these levels by a maximum of 2dB no more than one half of one percent of the time.

3. DESCRIPTION OF TECHNICAL SHARING CRITERIA.

3.1. Interference Sharing Criteria.

During coordination under the full band interference method, system operators would agree on changes to the parameters of their systems to reduce the amount of interference caused to other systems to the agreed upon levels. However, such agreements would only be necessary with respect to the limited number of parameters identified in this section, and each system operator would be able to optimize its system in terms of capacity, cost and service quality within these overall sharing constraints. Each of the parameters on which agreement is to be reached during the coordination process is discussed in the following subsections.

3.1.1. Maximum Downlink PFD Spectral Density. In the downlink direction, the key interference parameter is the total amount of interfering power presented to the receiving mobile terminal, and this interference level can most readily be defined as a maximum permissible PFD spectral density value. Because of the constantly changing geometry of LEO systems and the number of satellites visible at any particular moment at a point in the service area being coordinated, the value of maximum PFD spectral density should be specified as the maximum PFD spectral density that is permitted at any point in the service area from the aggregate of all satellites in the interfering system. It may be desirable to average the maximum permissible PFD spectral density limit over an appropriate and agreed upon period of time to recognize that certain peak system configurations would occur for only small percentages of the time, and such peak configurations and/or operating conditions should be excluded from calculating the aggregate maximum system PFD spectral density. Polarization effects shall also be considered when calculating the maximum PFD spectral density.

This maximum PFD spectral density per system is determined on the basis of achieving coordination between multiple satellite systems and is independent of other PFD spectral density constraints on a per satellite basis that are used as the bases for international coordination of MSS downlinks with terrestrial services under Resolution 46 and the trigger values of RR 2566. This matter is discussed in Section 7 of this Report.

3.1.2. Maximum Aggregate EIRP Areal Spectral Density. In the uplink direction, the key interference parameter is the total interference power presented at the satellite receiver input, and this value can be most conveniently controlled in the coordination process by setting a limit on the aggregate EIRP areal spectral density simultaneously radiated by all user terminals for a single interfering system that may be located within an appropriately sized reference area within the service area being coordinated. Because of different beam sizes used in the various proposed satellite systems, such aggregate EIRP areal spectral density levels may have to be specified for a set of reference averaging areas that approximate the range of beam sizes being coordinated. Some time averaging may also be desirable to account for short-term peak situations due to random access channels and power control system transients.

It should be noted that these aggregate EIRP areal spectral density limits are independent of the maximum EIRP areal spectral density limits imposed on each user terminal as a result of sharing with other services in the band, i.e. either -15 dBW/4 kHz or -3 dBW/4 kHz depending on the transmitting frequency. This matter is discussed in more detail in Section 7 of this Report.

3.1.3. Polarization. The sense of polarization used should be specified, although only circular polarization is assumed for the user terminal antennas. While the amount of intersystem isolation due to use of different sense of circular polarization in the service link that can be assumed in coordination may be small, any amount of isolation can provide a usable increase in system capacity under full band interference sharing conditions.

3.1.4. Frequency plans. System operators would be required to specify their satellite frequency plans in terms of the individual radio frequency channels (center frequency and bandwidth) used in their system.

3.1.5. Code Structures and Associated Cross-correlation Properties. There is no shortage of available pseudorandom noise codes that can be selected by a CDMA system operator to insure satisfactory operation of their system. However, there is a small probability that system operators can independently select codes that have cross-correlation artifacts that produce more interference than would be the case of the flat gaussian noise usually assumed in the intersystem interference calculations. For this reason, coordination between system operators would include identification of their code structures to insure that the codes selected have sufficiently good cross-correlation properties that the effects of intersystem interference are no worse that flat gaussian noise.

3.1.6. Antenna Beam Patterns. Antenna beam patterns (number of beams, pointing angle of maximum gain, sidelobe gain patterns and beam array layout), together with frequency plans, can be used to represent the distribution of PFD spectral/EIRP areal spectral density across service area and the assigned frequency band.

3.1.7. Signal Burst Structures. If a system uses a form of transmission that does not radiate a continuous signal, the time dependent characteristics of the transmission should be described in such terms as peak/average power levels, duty cycle, framing and guard time structure, burst synchronization characteristics, etc.

3.1.8. Overall Interference Allowance. The total level of interference from other licensed MSS systems in the band that can be tolerated by a single system.

3.2. Out-of-Band Emissions Mask Between Band Segments.

3.2.1. General Introduction. The out-of-band emission rule currently found in Section 25.202(f) needs to be updated to reflect the operation of MSS systems. It is proposed that Section 25.202 be amended to specify a power spectral density (PSD) mask measured relative to the average in-band PSD at the maximum design power setting for the 1610-1626.5 MHz and 2483.5-2500 MHz bands.

The following is a discussion of why the current rule should be amended. The proposed systems have varying bandwidth and modulation types. Amending Section 25.202 to specify a PSD mask will protect other services and other MSS systems from the sum of the out-of-band emissions from many overlapping CDMA carriers or multiple side-by-side FDMA/TDMA carriers. The current rule specifies the out-of-band PSD relative to the transmitter carrier power. This does not adequately account for multiple carriers. A PSD mask can also more adequately be applied to systems with varying bandwidth.

Each system in the MSS bands should be protected from the other systems to a reasonable level. The proposed rules specify emission limits in terms of out-of-band PSD relative to in-band PSD across the CDMA to FDMA/TDMA band segment. This will control interference between dissimilar system types. This rule provides adequate protection from the emissions of the uplinks of a large number of mobile units. A more detailed discussion is provided below.

The recommended integration (reference) bandwidth is either 3 kHz or 4 kHz. A 3 kHz integration bandwidth is available on standard test equipment which will simplify measurement. A 4 kHz bandwidth matches previous practice and is in common use. Since the recommended rules are based on a PSD mask, the exact bandwidth of the measurement is not important.

3.2.2. Uplink Out-of-Band Emissions Limits. Table 3-1 contains the proposed uplink out-of-band emissions limits. The table forms a power spectral density (PSD) mask which, in part, protects FDMA/TDMA or CDMA receiving satellites from emissions from numerous mobile units in another frequency channel transmitting a CDMA or FDMA/TDMA signal. The mask also provides protection out of the MSS uplink band.

Table 3-1

FDMA/TDMA and CDMA Uplink Out-of-Band Emissions Limits

Attenuation[5]	Frequency Separation[6]
26	>0.5b + r/2 through 1.5b[7]
38	>1.5b through 2.5b
45	>2.5b

The measurement methodology must be based on average power measurements at the maximum design power settings. In the event that out-of-band emission levels are shown to be below measurable amounts equal to the background noise level of reasonably sensitive test equipment, then the above attenuation levels are considered satisfied by out-of-band emissions which are under the noise floor.

In the event that the out-of-band PSD mask in Table 3.1 is not met, a waiver to this mask may be allowed if there is a showing that the operation of the equipment will not cause harmful interference to other systems or services or if it is shown that the out-of-band PSD is below an interference level coordinated with potentially interfered-with systems (as referred to in Section 3.1.2).

---

[5] "Attenuation" is the attenuation of the average out-of-band emissions power measured in a reference bandwidth, r, relative to the average over the authorized bandwidth in-band power measured in the reference bandwidth. The attenuation levels define a power spectral density mask. The transmitter power level should be set to the maximum design power and loading.

[6] The "Frequency Separation" is the frequency difference between the assigned frequency and the center frequency of the reference measurement bandwidth.

[7] The "authorized bandwidth", b, is the larger of the occupied bandwidth (the 99% power bandwidth) or the necessary bandwidth of the transmitted signal.

3.2.3. Uplink Emission Limitations Between Band Segments. A limitation on the out-of-band segment emissions needs to be established to minimize the intersystem interference between systems operating in different segments of the spectrum in a band segmentation approach. The amount of isolation that is required between the band segments will be dependent on the number of systems that are operating and other system parameters. At this point in time it is premature to specify a fixed isolation number, since the total number of foreign and domestic systems that will be operating in the vicinity of the U.S. is unknown. Currently a 45 dB isolation is proposed for good protection between an FDMA/TDMA system and a CDMA system or systems that are operating at or near capacity. This assumes representative design parameters for the systems. An isolation number like this will be the subject of coordination among the system operators and will dictate the amount of guardband, if any, required from the edge of the band to the carrier frequency of the nearest channels of the FDMA and the CDMA systems.

3.2.4. Downlink Out-of-Band Emissions Limits. Table 3-2 contains the proposed downlink out-of-band emissions limits. The table forms a power spectral density (PSD) mask which protects FDMA/TDMA or CDMA receiving mobile units from emissions from satellite downlinks in another band within the 2483.5-2500 MHz band or within the 1613.8-1626.5 MHz secondary downlink band. The mask protects MSS uplinks from out-of-band emissions from a secondary downlink in the 1613.8-1626.5 MHz band. The mask also provides protection to other systems operating out of the MSS bands.

This table may not apply within the CDMA band, and the out-of-band emissions can be the subject of coordination.

Table 3-2

FDMA/TDMA and CDMA Downlink Out-of-Band Emissions Limits to Protect Other MSS Downlinks

Attenuation[8] (db)	Frequency Separation[9]
25	>0.5b + r/2 through 1.5b[10]
35	>1.5b through 3.0b
43	>3.0b

8 "Attenuation" is the attenuation of the average out-of-band emissions power measured in a reference bandwidth, r, relative to the average over the authorized bandwidth in-band power measured in the reference bandwidth. The attenuation levels define a power spectral density mask. The transmitter power level should be set to the maximum design power and loading.

9 The "Frequency Separation" is the frequency difference between the assigned frequency and the center frequency of the reference bandwidth.

10 The "authorized bandwidth," b, is the larger of the occupied bandwidth (the 99% power bandwidth) or the necessary bandwidth of the transmitted signal.

4. OPERATING CONSTRAINTS AND CRITERIA NECESSARY TO PROTECT PRIMARY UPLINKS FROM SECONDARY DOWNLINKS

4.1. Introduction

This section of the Report discusses potential interference to primary MSS uplinks in the 1610-1626.5 MHz band from secondary downlinks in all or a segment of the 1613.8-1626.5 MHz band and discusses possible methods available to mitigate the interference.

A potential for in-band interference arises where a U.S.-licensed system uses the secondary downlink on full or partial co-frequency, co-coverage with another U.S. or foreign system's primary uplink anywhere in the world.

A potential for out-of-band interference arises where a U.S.-licensed system uses one segment of L-band co-coverage with the primary uplink of another U.S. or foreign system operating in a different L-band segment anywhere in the world.

4.2 Regulatory Background

WARC-92 allocated the 1610.0-1626.5 MHz band to the Mobile-Satellite Service (Earth-to-space) on a primary basis in all three ITU Regions. WARC-92 also allocated the 1613.8-1626.5 MHz band to the Mobile-Satellite Service (space-to-Earth) on a secondary basis in all three ITU Regions. Footnote 731Y states: "The use of the band 1613.8-1626.5 MHz by the mobile-satellite service (space-to-Earth) is subject to the application of the coordination and notification procedures set forth in Resolution COM5/8 [Res 46]." Footnote 731X includes virtually the same wording in relation to the use of the 1610-1626.5 MHz band for MSS and RDSS for Earth-to-space transmissions.

4.2.1 Radio Regulations

Radio Regulations Article 8, Section II (RR 420 et.seq.) states :

"Stations of a secondary service:

a) shall not cause harmful interference to stations of primary or permitted services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

b) cannot claim protection from harmful interference from stations of a primary or permitted service to which frequencies are already assigned or may be assigned at a later date;

c) can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date."

Sections 2.104(d)(4) and 2.105(c)(3) of the Commission's Rules are identical to Radio Regulations 420 through 423.

4.2.2 Definition of Harmful Interference

"Harmful interference" has been defined both by the FCC and the International Telecommunication Union (ITU) as follows:

> "Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with these Radio Regulations"
>
> 47 C.F.R. Section 2.1; see also ITU Radio Regulations Art. 1, Section 7.4 (para. 163).

4.3 Interference Mechanisms

In this section of the report which deals with specific interference mechanisms, reference will be made to "interfering" and "victim" satellites. The interfering satellites are those using the secondary downlink and the victim satellites are those using the primary uplink. Note that in the case of a TDD (Time Division Duplex) system co-frequency use is made of both secondary downlinks and primary uplinks, which creates the potential for self-interference. The avoidance of this interference mechanism is also discussed below.

A secondary downlink could potentially interfere with co-frequency primary uplinks due to radiation from the interfering satellites which may be captured by the antenna of the victim satellites. This includes radiation that has a direct line-of-sight between the interfering and victim satellites and also radiation that might reflect, under certain geographical and geometrical situations, from the surface of the earth. Annex 4.3 addresses this issue.

4.3.1 Intra-System Interference

This section deals with the potential for interference between different satellites of the same satellite system. In this case it is concerned only with systems that employ both the secondary downlink and primary uplink in a co-frequency TDD manner, such as the proposed Iridium system.

It was noted (in IWG1-25) that inclusion of sufficient time guard bands between receive and transmit bursts would ensure that the Iridium system would not self-jam. This is because the interference mechanisms are entirely predictable -- based on the geometry of the constellation -- and can be avoided by proper design. At worst, the horizon-to-horizon range between Iridium satellites will be 6500 km. However, under this scenario, the potential interfering downlink source will arrive at the victim satellite during the guard time included in the frame. This guard band is sufficiently wide to protect the victim satellite from the interfering satellite's downlinks during all other possible constellation geometries.

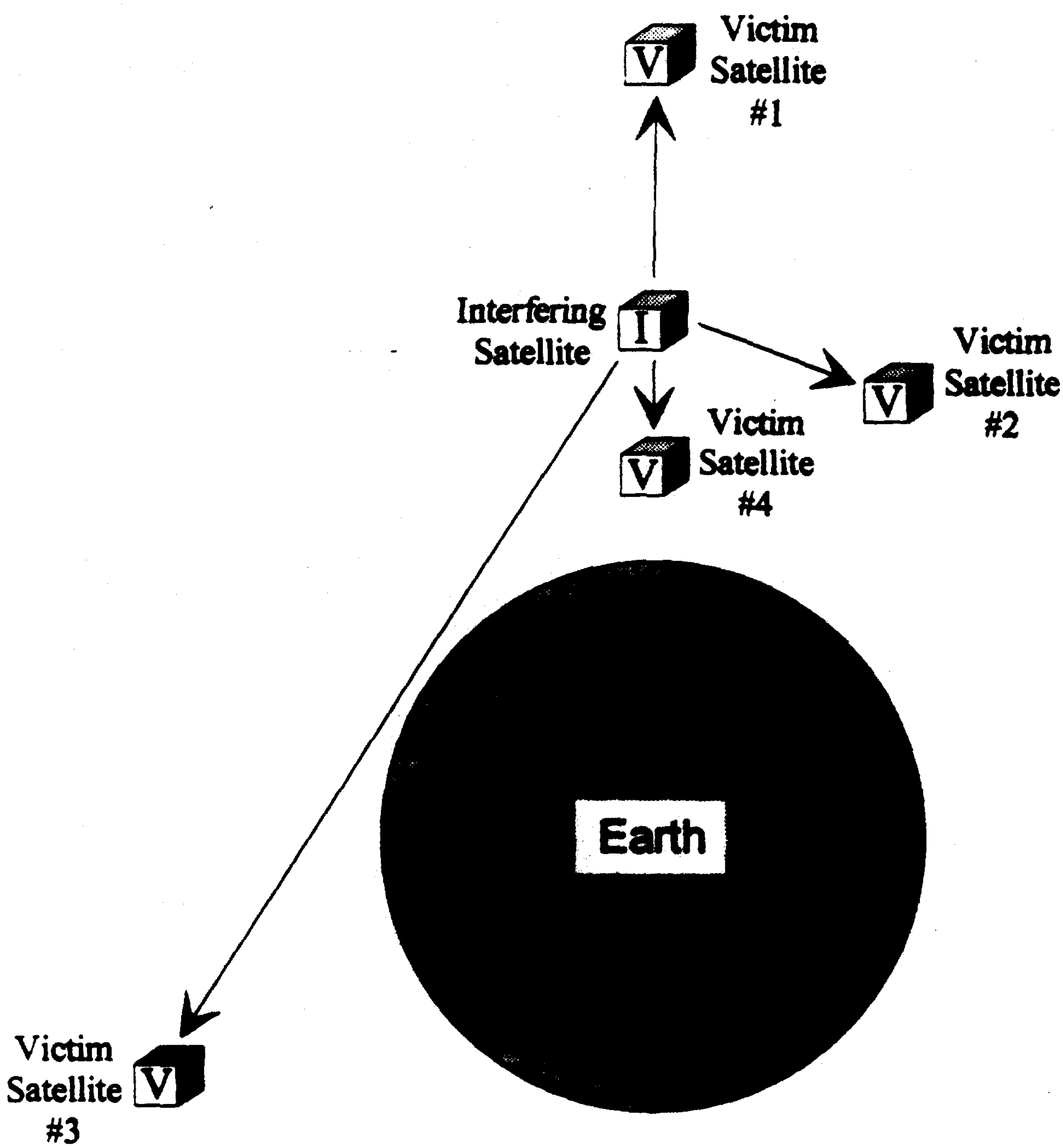


Figure 1 - Interference Mechanisms

4.3.2 Inter-System Interference

This section deals with the interference between different satellite systems, sharing the same frequency band.

Figure 1 shows an example of the ways in which the direct line-of-sight interference mechanism might occur. There is an additional potential interference mechanism resluting from the reflected energy from the earth's surface, and this effect is considered in Annex 4.3. Figure 1 shows the direct line-of-sight interference paths between a single interfering satellite and four possible victim satellites. In reality there will, of course, be many interfering and victim satellites, and their position relative to each other will be constantly changing. Each of the four cases of interference is described briefly below:

Case 1:	Victim satellite #1 is in a higher orbit than the interfering satellite. The minimum spacing between the satellites will be determined by the difference in orbit altitudes of the interfering and victim satellites. The potential interference is from the backlobe of the interfering satellite into the mainlobe of the victim satellite.
Case 2:	Victim satellite #2 is shown to be in an orbit of comparable or higher altitude to that of the interfering satellite. As such there will be times when the interfering and victim satellites may be relatively close to one another. In this case the potential interference is from the sidelobe of the interfering satellite into the sidelobe of the victim satellite.
Case 3:	Victim satellite #3 may be in any orbit. The characteristic of this case is that the potential interference path is just over the horizon of the Earth. Therefore the potential interference may be from the mainlobe of the interfering satellite into the mainlobe of the victim satellite. The potentially high antenna gains for this interference link are partly offset by the larger link distances involved.
Case 4:	Victim satellite #4 is in a lower orbit than the interfering satellite. The minimum spacing between the satellites will be determined by the difference in orbit altitudes of the interfering and victim satellites. The potential interference is from the mainlobe of the interfering satellite into the backlobe of the victim satellite.

4.4 Co-Frequency Interference Analyses

This section provides the key elements of a co-frequency and a non-co-frequency interference analysis that takes account of the four potential line-of-sight interference cases described in section 4.3.1 above.

The interference analysis can be broken down into five separate parts, as follows:

1. Establish the relevant data that adequately defines the emissions from the interfering satellites;
2. Establish the relevant data that determines the geometry between the interfering and victim satellites;
3. Establish the appropriate parameters of the victim link in order to assess its sensitivity to interference;
4. Calculate the effect of the interference in relation to the wanted signal power to ascertain the relative impact of the interference.
5. Consider the time varying nature of the interference effect.

These five parts are dealt with individually below:

4.4.1 Interfering Satellite Emissions

The parameters developed in this section are specific to the proposed Iridium system.

Annex 4.1 provides the derivation of the average Iridium backlobe, sidelobe and mainlobe (trans-horizon) EIRP spectral density. The results are as follows:

Backlobe EIRP:	-60.9 dBW/Hz
Sidelobe EIRP:	-41.9 dBW/Hz
Mainlobe (Trans-Horizon) EIRP:	-33.8 dBW/Hz

4.4.2 Satellite-to-Satellite Link Geometry

Table I provides the minimum range distances between the Iridium satellites and the victim satellites, for each applicant's (and Celsat's) satellite orbit, including the corresponding values of space loss at 1618 MHz. Note that, because the Iridium orbit altitude is lower than any of the other systems' (active) orbit altitudes, Case 4 is not applicable, and so is not included in the analysis from here on.

Interference Case		AMSC	Const'n	Ellipsat	Glob'lst'r	Odyssey	Celsat
Case 1: Backlobe	Range (km)	35,003	261	5,289	634	8,581	35,003
	Sp Loss (dB)	187.5	145.0	171.1	152.7	178.3	187.5
Case 2: Sidelobe	Range (km)	41,529	6,799	6,934	7,171	16,121	41,529
	Sp Loss (dB)	189.0	173.3	173.4	173.7	180.8	189.0
Case 3: Trans-Hor'n	Range (km)	44,925	7,039	5,805	7,726	18,737	44,925
	Sp Loss (dB)	189.7	173.6	171.9	174.4	182.1	189.7

Table I - Minimum Range and Corresponding Space Loss (at 1618 MHz)

4.4.3 Victim Link Sensitivity

The appropriate point in the victim link, at which to compare the wanted and interfering signal levels, is at the input to the victim satellite receive antenna. At this point the measure of signal power is "the power spectral density that would be received by an isotropic antenna located at the satellite", or EIRxPSD (Effective Isotropic Received Power Spectral Density). This is given by the mobile EIRP Spectral Density minus the Space Loss. The minimum EIRxPSD densities, per voice channel, for each of the applicants' (and Celsat's) systems, as provided by each system's proponent, are given in Table II, together with other parameters used later in the analysis:

CDMA System	$EIRxPSD_{min}$	Spreading Gain	Max trans-horizon gain rel. to peak gain ("X")
AMSC	see Note 1	30.6 dB	-3 dB
Constellation	-233.8 dBW/Hz	24.2 dB	-3 dB
Ellipsat	see Note 1	see Note 1	-3 dB
Globalstar	-230.1 dBW/Hz	24.2 dB	-3 dB
Odyssey	-259.5 dBW/Hz	35.4 dB	-3 dB
Celsat	-258.8 dBW/Hz	24.2 dB	-3 dB

Table II - System Specific Data for the Victim CDMA Systems

Note 1: This data is not yet available.

The above minimum EIRxPSD values apply to interference received in the mainbeam of the victim satellites. This applies in the situation of interference from the backlobe of the Iridium satellite (Case 1), and potentially in the situation of trans-horizon interference (Case 3). For Case 2 (Iridium sidelobe) it is appropriate to consider that the interference is being received through a sidelobe of the victim satellite. It is assumed that all such sidelobes are 20 dB below the peak of the main beam gain. This factor is therefore taken into account in calculating the interference for Case 2 (see below).

4.4.4 Calculation of Interference

The effect of interference into a CDMA system will be either a degradation in service quality, or a loss of capacity. The following analysis assumes that the impact of the interference is in terms of loss in capacity, while maintaining the existing traffic at the quality obtained without the interference. The impact of the interference, when measured in this way, can be determined from the ratio of the interfering to the wanted (per voice channel) signal spectral densities (I_o/C_{1o}). This ratio gives the number of wanted channels, within the spread bandwidth and within the particular beam, that will be displaced by the interference.

The ratio, I_o/C_{1o}, can be calculated for each of the relevant interference cases, using the following equations:

$$\begin{array}{lll}
\text{Case 1 (Backlobe):} & I_o/C_{1o} = -60.9 - S - EIRxPSD_{min} \ldots\ldots & (1) \\
\text{Case 2 (Sidelobe):} & I_o/C_{1o} = -41.9 - S - EIRxPSD_{min} - 20 \ldots\ldots & (2) \\
\text{Case 3 (Trans-Horizon):} & I_o/C_{1o} = -33.8 - S - EIRxPSD_{min} - X \ldots\ldots & (3)
\end{array}$$

where:	S	=	Space Loss (in dB) (derived from Table I in Section 4.4.2)
	$EIRxPSD_{min}$	=	Minimum Operating EIRxPSD per voice channel (in dB) (derived from Section 4.4.3)
	X	=	Max trans-horizon gain relative to peak gain (in dB) (derived from Table II)

Note that, in the case where the spread bandwidth exceeds the total bandwidth used by the Iridium system, the value of I_o/C_{1o} must be correspondingly reduced.

Table III below gives the results obtained using the above method: